MW/LW LOOP AERIALS

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It has been said that more broadcasting takes place on the medium waves than on all of the short wave bands put together. There are literally thousands of stations throughout the world operating on frequencies between 535kHz and 1605kHz. The latest counts reveal over 4000 in the United States alone! Inevitably this means frequency sharing, with many simultaneous broadcasts on a single channel, and the problem confronting the m.w. DXer is: how do I deal with co-channel interference?

The receiver cannot do it. Selectivity is the ability to select stations that are on different frequencies, so the problem does seem insoluble. Often it is. If, however, two stations on the same frequency lie in different directions from the DXer's QTH, it ought to be possible to separate them with a directional aerial. The internal ferrite rod aerial used in portable receivers is directional. Tune round the medium waves after dark until you come across two stations jumbled up together. Rotate the receiver about its vertical axis and you may find that you can listen to one station on its own with the receiver in one position and to the other station alone, with the receiver in another position. It is quite a fascinating exercise: anyone interested in "local radio" DXing should try it.

A ferrite rod aerial does not pick up enough signal to satisfy the m.w. DXer, so the m.w. loop has been developed (Fig. 1). It has a pick-up somewhere between that of a long wire and a ferrite rod aerial.

How does it Work?

Imagine a single-turn loop placed vertically so that its plane is broadside-on to an incoming signal. The wavefront will strike both vertical wires simultaneously, and equal, in-phase voltages will be induced in them, i.e. when the top of one vertical wire is positive then the top of the other will also be positive (Fig. 2). These two voltages are in opposition! Trace the path round the loop and you will find $- + + -$, so the net voltage applied to a receiver would be zero. This is the position of minimum pick-up, the null.

Now turn the loop through 90 degrees, so that the two vertical wires are in-line with the transmitter. The wavefront will strike the nearer of the two verticals before it reaches the second. There will be a phase difference: unequal voltages (at any instant) will appear across the two verticals and the difference between them is signal available to be applied to the receiver. This is the position of maximum pick-up.

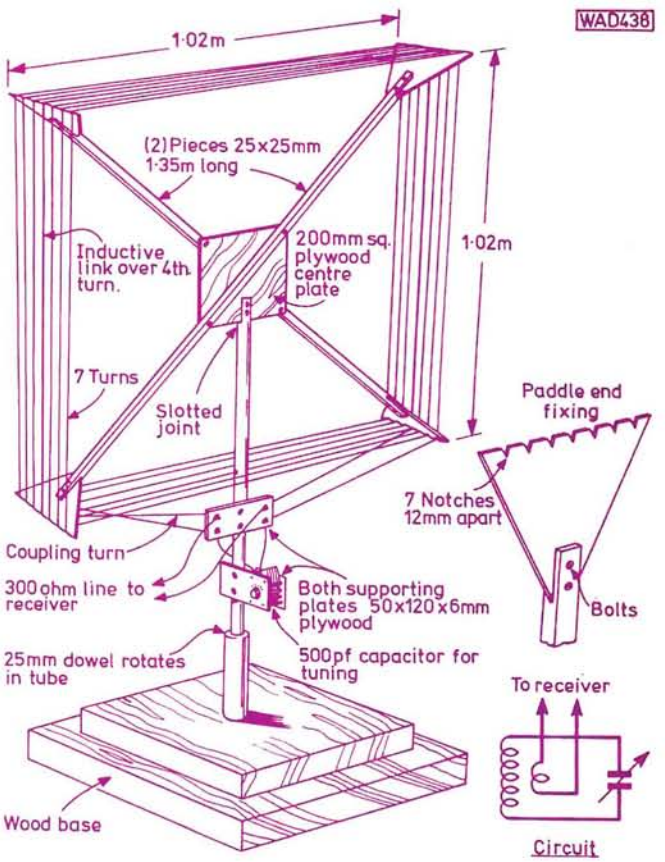

Fig. 1: Constructional details of the standard "40 inch" box loop for medium wave use, with corresponding theoretical circuit

A loop follows a cosine law. $V = V_{max} \cos \theta$ where θ = the angle between the direction of maximum pick-up and the direction the loop is actually pointing. V equals the signal pick-up from that direction. It is easy to plot a curve called a figure-of-eight (Fig. 3) using this formula. The loop is at the centre of the figure-of-eight and the distance from it to the curve is proportional to the signal pick-up in that direction.

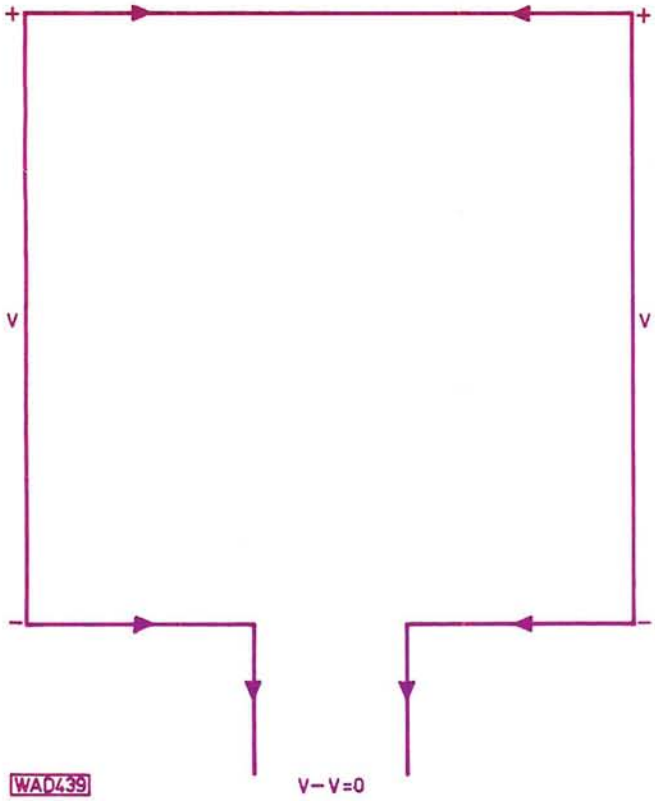

Fig. 2: Voltages induced in a single-turn loop, broadside-on to the transmitter, cancel to produce a null output

From this figure-of-eight polar diagram, two important features of a loop emerge:

a) The null is sharp while the maximum is broad. A loop is used to null-out QRM. It is the null that matters, not the maximum.

b) There are two nulls spaced 180 degrees apart. The loop will not null-out QRM coming from the opposite direction to the DX. It will null-out both of them together, which is not very helpful.

The Standard "40 inch" Loop

DXers in the UK have, after a lot of experimenting, produced the "40 inch" box loop shown in Fig. 1. It is a compromise between convenience and electrical performance. There are **two** windings. The main winding consists of seven turns, the two ends going to the tuning capacitor to form a tuned circuit. The second winding, which is a single turn, is wound next to the centre turn of the main winding and it picks up signal from the main winding by induction. This signal is then led off to the receiver.

The wire used for both windings is 22 s.w.g. single-conductor, plastic-covered copper wire known as hook-up or connecting wire and approximately 34m of it is required. It is desirable to use balanced feeder to connect the coupling winding to the receiver. My preference is for 300 ohm flat twin feeder, but plastic-covered lighting flex will do instead. The feeder is connected to the dipole (A, A1) terminals at the receiver, or to the Aerial and Earth sockets if there is no dipole input. The feeder goes direct to the receiver and **NOT** via an aerial tuning unit (a.t.u.).

A loop is easy to use. Tune the receiver to the wanted station. Peak it up with the loop tuning control. Rotate the loop until you get the best results. A loop can be used to reduce static (atmospherics) if it is coming from a single direction e.g. from the south during the summer. Rotate the loop until the static is reduced or it disappears. Similarly with sideband splatter. Peak the loop onto the desired station and rotate the loop until the splatter is reduced. Overloading in the early stages of a receiver is often prevented when a loop is used, giving rise to the unlikely but accurate claim that a loop will sometimes improve audio quality.

Problems with Loops

A number of *PW* readers have highlighted problems encountered while building or using a loop. The most usual is that the loop will not tune across the entire band. For example, it may only cover 540kHz to 1450kHz. If so, then you will have to reduce the number of turns, so remove one complete turn. If you remove only part of a turn you will affect the null. The loop, which now has six turns, may cover 600kHz to 1650kHz. You need more capacitance. Try a 220pF fixed capacitor in parallel with the tuning capacitor, but you will have to fit a switch and cover the band in two steps Fig. 4. The number of turns affects the h.f. end of the range. If the loop tunes too high then more turns are needed. If it does not tune high enough in frequency then fewer turns are needed. The capacitance affects the l.f. end. Too low a frequency, too much capacitance. Not low enough, too little. Adjust the h.f. end first and then the l.f. end.

It is not always possible to obtain a 500pF variable capacitor so use the nearest value you can get hold of. A twin-gang 330pF (per section) with the two sections in parallel i.e. both sets of moving vanes joined together and also the two sets of fixed joined to each other, gives a total of 660pF which should cover the band easily. Similarly, a 330pF variable with a 220pF fixed in parallel via a switch, will cover the band in two steps.

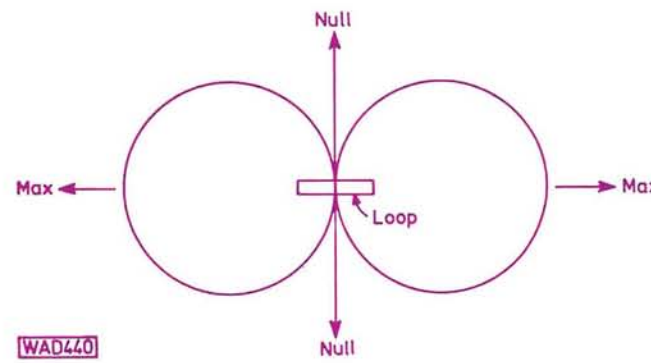

Fig. 3: The "figure-of-eight" polar response pattern of a loop aerial

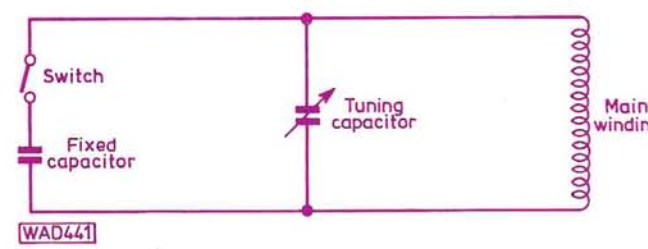

Fig. 4: Adding a switchable fixed capacitor allows a wider band to be covered in two ranges

What Type of Wire?

The type of wire for the windings is determined mainly by its mechanical properties. If the wire is too thin then it will break easily. If it is stranded then it may not be rigid enough.Too thick and a lot of force is needed to tension it. If it is made of steel it will be too springy (I have tried it with plastic-covered garden wire). Use the wire specified if you can get it. If not, use what is available.

Feeder

Some DXers use coaxial cable to join the loop to the receiver, which is a pity. You do not want the feeder to act as an aerial and pick up the station that is being nulled out by the loop. With balanced feeder the signal picked up by each of the two wires will be equal in value and will pass through the receiver in opposite directions (from A to A1 and from A1 to A). Since they are equal they will cancel out and the nett pick-up will be zero. When using coaxial cable, which is unbalanced, the screen will pick up more than the inner wire because the latter is screened. This may not matter too much if the receiver does not have a balanced input, but where dipole terminals are available, use balanced feeder.

Size

One of the most frequent questions is: "Can I use a different size loop?"

Yes you can. The pick-up of a loop depends on two factors: the number of turns and the area enclosed by them. As the turns are in series, the voltage developed across each will add up, so clearly the more turns the greater the pick up. You can compare two loops by using the formula At (A times t). The "40 inch" loop with 7 turns gives A = 1·04m² and t = 7 so At = 7·28. A "20 inch" loop with 13 turns gives A = 0·26m² and t = 13 so in this case At = 3·38. The "40 inch" has more than double the pick-up of the "20 inch"; 7·28 ÷ 3·38 = 2·15 times, to be exact.

You will find that large loops pick up more but are clumsy to use. Small loops are more convenient but they deliver a lot less. The "40 inch" is a good compromise, but if it is too large then try a "20 inch". Reader Bob Bell has developed a "20 inch" box loop with 13 turns for the main winding and a single turn for the coupler. It is tuned in two ranges with a total capacitance of 750pF.

Shape

Any shape that is symmetrical will do—round, rectangular, diamond or even triangular. A triangle with a short base and a high apex is used by some DXers in the United States, where it is known as the Wedge or Delta loop. The diamond is used by a few enthusiasts and where the main winding has all the turns in the same plane it is known as the Spiral Loop, which is the type I use (Fig. 5). Each turn is of a different size of course. In theory you will get a better null if the turns are all in the same plane, compared with the box winding used in the standard loop. In fact, the effect is very small with the standard loop, but it can be significant with loops that have a large number of turns.

It is very easy to knock up a spiral loop. Two pieces of wood, some tacks to hold the windings in place, 31m of wire, a tuning capacitor and there you are. It is a lot more difficult to make a good job of a spiral loop and I would hesitate before making another one.

Long Wave Loop

You can get a m.w. loop to work on the long waves by inserting a loading inductor in series with the main winding. I use a Repanco High Q Choke type CH1 which has an inductance of 2·5mH but any value between 2·5mH and 5mH will do. Unsolder one of the loop wires from the tuning capacitor and join it to one side of the inductor. Join the other side of the inductor to the vacated tag on the tuning capacitor.

Alternatively, you can extend the range of a loop by adding parallel fixed capacitance across the tuning capacitor, but the values required are so large (2200pF to reach 300kHz and 7000pF for 150kHz) that the tuning capacitor no longer functions. This will not matter, though, if you only want to listen to a single station, and this method is employed by Arthur Tate in the Shetlands, who endeavours to get better reception on 200kHz this way.

If you want to wind a special long wave loop then approx. 3½ times the number of turns (25–28 for a "40 inch") are needed, but this loop will pick up 3½ times the signal of a m.w. loop with loading coil, which may justify the effort in building it.

Tilting

This is not a medieval past-time! It is a method of increasing the depth of the null when the wavefront is twisted or rotated. It is popular with DXers in the United States, who have a lot of locally-produced QRM to deal with. When a station is being nulled out, the loop will be broadside-on to the incoming signal. If you pick up the loop and tilt it towards, or away from the station, at the same time holding the null position, you may get a deeper

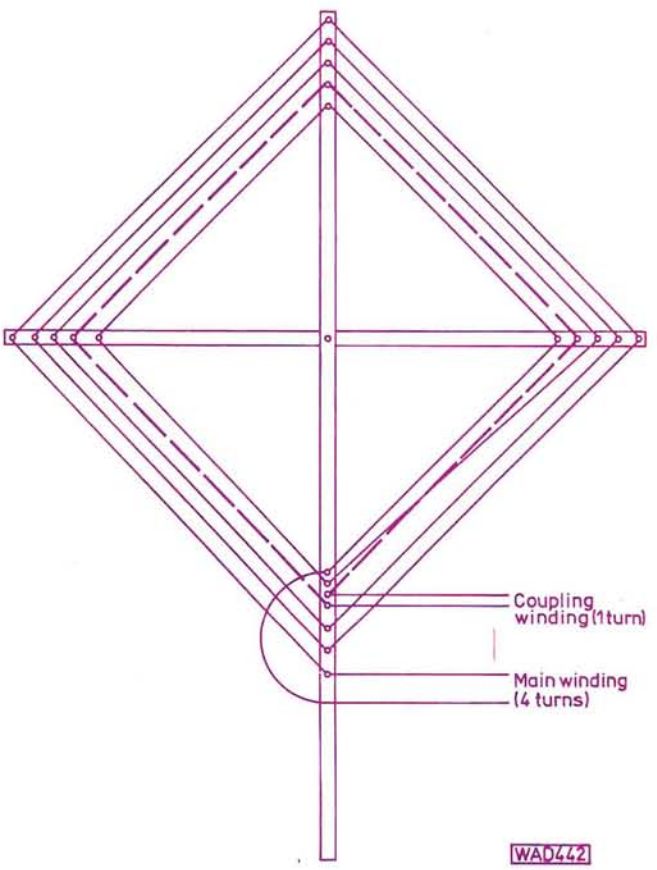

Fig. 5: Arrangement of a spiral loop

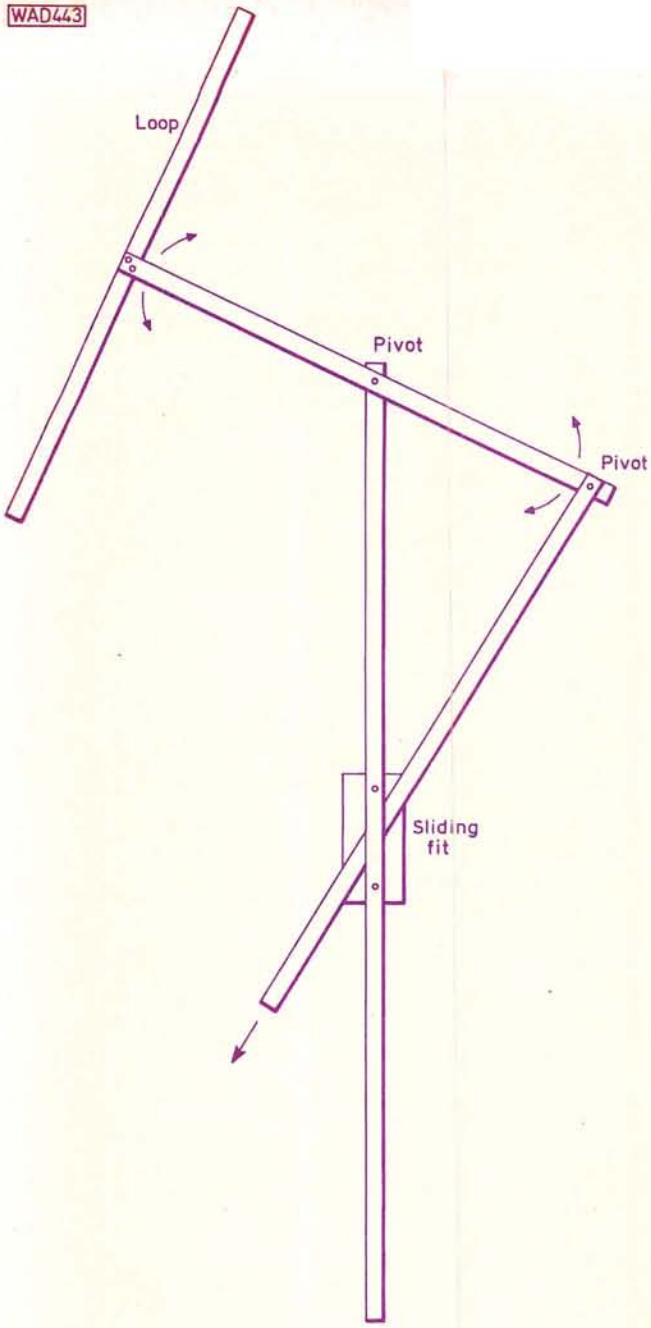

Fig. 6: Details of a simple wooden mounting which allows a loop to be tilted from the vertical

null. You can modify a normal loop so that there is no need to lift it off the floor. One method of doing this is shown in Fig. 6.

Coupling Winding

The single turn on the standard "40 inch" loop is called the coupling winding and its existence has puzzled quite a few readers. This winding is not joined in any way to the main winding. It is quite separate since the transfer of signal from the main winding is by induction. Why use a coupling winding? If you joined the main winding direct to the receiver then the loop would be damped and detuned by it. The two are in effect a 7:1 step down transformer which provides a better match.

Portable Receivers

Many DXers try to use a loop with a portable, forgetting that the receiver already has an aerial of its own. No null, is the result. If the loop nulls out a station then that station is still picked up by the internal aerial. You could of course rotate the portable as well as the loop and null out the QRM with both aerials, but in practice this would be very difficult to do. The solution of course, is to mount the receiver on a shelf near the centre of the loop so that the two nulls co-incide and loop and receiver can be rotated together. This arrangement really does work.

There is no need to connect the loop to the receiver, as inductive coupling will take place between loop and internal ferrite rod aerial. In fact if you build a loop solely for use with a portable you need not bother with a coupling winding at all. It is easy to check if the receiver has an internal aerial. If it can pick up stations on the medium waves without an external aerial, then obviously there must be an internal one.

The better type of portable receiver performs really well on the short waves but the pick up via the internal aerial is not great enough for serious DXing on the medium waves. This method of using a loop with a portable is really the only way that such a receiver will "deliver the goods" on the medium waves. DXers seriously interested in the medium waves should turn away from portables, even those with the title "communications" and look for a receiver such as the DX160, SRX-30, FRG-7, Trio 9R59-D/E, CR100 or AR88 which really are communications receivers. Be careful with the DX160. Some versions have a ferrite rod aerial attached externally to the rear which must be disconnected before a m.w. loop can be used. ●

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